Predicting beef cut composition and meat quality traits by spiral computed tomography

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Introduction Carcass composition and meat traits are relevant for the definition of beef quality. Direct assessments of both groups of traits require the slaughter of the animal and are costly and time-consuming, which has limited the inclusion of quality traits in breeding programmes. X-ray computed tomography (CT) is a non-invasive technique that provides accurate predictions of beef carcass composition (Navajas *et al*., 2009). Studies in sheep showed that average CT muscle density is correlated with intramuscular fat content, fatty acid profile and eating quality (Bishop and Karamichou, 2009). The aim of this study was to assess the potential of CT tissue density values, analysed using a multivariate approach, as predictors of beef cut composition and meat quality in Aberdeen Angus and Limousin crossbred cattle.

Material and methods Data was recorded on 88 Aberdeen Angus (AAx) and 106 Limousin (LIMx) crossbred heifers and steers that were slaughtered with average live weights of 582 and 609 kg and ages at slaughter of 546 and 544 days for AAx and LIMx, respectively. After slaughter, the left carcass sides were kept and chilled for 48 h. After quartering, 11-12th rib and lumbar sirloins were vacuum packed in the abattoir and transported at temperatures of 1-2 °C to the SAC-BioSS CT unit. Spiral CT scans (SCTS) were collected of each cut using a Siemens Somatom Esprit scanner. They were subsequently transported to the University of Bristol for dissection into subcutaneous and intermuscular fat and muscle, and meat quality analysis (colour, instrumental texture and sensory traits; Prieto *et al*., 2009a) (fatty acid and intramuscular fat content; Prieto *et al*., 2009b). Multivariate calibration method (partial least square regression, PLSR) was used to predict beef cut composition and meat quality parameters using muscle and fat CT densities of cross-sectional images from either the 11-12th rib or lumbar sirloins as independent variables. Internal full leave-one-out cross-validation was performed in order to avoid over-fitting the PLSR equations using The Unscrambler program (version 8.5.0, Camo, Trondheim, Norway). The predictive ability of the PLS calibration models was evaluated in terms of coefficient of determination (R^2) and Root Mean Square Error of Cross-Validation (RMSECV).

Results Accuracy of CT-PLSR calibrations for cut composition and meat quality traits are presented in Table 1. Cut composition was predicted with high accuracy (R^2: 0.81 to 0.99). Accurate CT predictions were found for most fatty acids (R^2: 0.61 to 0.75) and intramuscular fat content (IMF, R^2: 0.71 to 0.76) in both breeds. However, low to very low accuracies were found for colour, instrumental texture and sensory traits with R^2 ranging from 0.01 to 0.26.

Table 1 Prediction statistics of cut composition and meat quality traits of beef

	Aberdeen Angus crossbred		Limousin crossbred	
	R^2	RMSECV	R^2	RMSECV
Subcutaneous fat/intermuscular fat/muscle (g)	0.94/0.81/0.99	34.6/161.5/58.5	0.92/0.86/0.97	34.5/42.2/57.4
L*/a*/b* colour	0.12/0.04/0.05	2.4/2.2/1.8	0.19/0.18/0.19	2.38/1.92/1.82
SSF3/SSF14/ Volodkevitch shear force (N)	0.06/0.13/0.26	67.4/34.2/11.8	0.16/0.10/0.03	70.9/33.3/14.6
Tenderness/juiciness/flavour	0.01/0.04/0.05	0.8/0.4/0.6	0.03/0.02/0.17	0.7/0.5/0.5
Palmitic/stearic/oleic acid (mg.100 g^{-1} muscle)	0.74/0.65/0.75	167.6/83.8/245.2	0.69/0.61/0.66	158.0/79.4/235.5
SFA/MUFA/PUFA (mg.100 g^{-1} muscle)	0.71/0.72/0.26	281.6/318.4/21.5	0.67/0.66/0.09	253.1/279.3/25.9
Intramuscular fat (mg FA.100 g^{-1} muscle)	0.76	567.4	0.71	539.1

SSF(3, 14): slice shear force 3 and 14 days pm, FA: fatty acid, SFA: saturated fatty acid, MUFA: monounsaturated fatty acid, PUFA: polyunsaturated fatty acid

Conclusions The multivariate analysis of SCTS of beef cuts provided very accurate estimations of tissue weights in both AAx and LIMx and yielded accurate predictions of the IMF content and fatty acid composition in both breeds, without damaging or devaluing the cuts. The accuracies of these predictions were higher in AAx than in LIMx beef samples, probably due to a higher concentration of IMF in the former. No reliable CT predictions were found for colour, instrumental texture and sensory traits. The CT prediction of beef meat and carcass quality traits simultaneously may be of valuable information for beef cattle breeding programmes.

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